

A REDESCRIPTION OF *OCTOPUS ORNATUS* GOULD, 1852 (OCTOPODA: CEPHALOPODA) AND THE STATUS OF *CALLISTOCTOPUS* TAKI, 1964

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Abstract.—*Octopus ornatus* is redescribed based on specimens from Hawaii, Bikini Atoll, and Kenya. Variations of mantle shape and color patterns are described and illustrated as well as internal anatomical features. *Callistoctopus arakawai* is placed in the synonymy of *Octopus ornatus*. Taki's statement that his specimen exhibited luminescence is refuted by observations of living specimens in Hawaii. As the original type-material is lost, a large male specimen from Oahu, Hawaii, the type-locality, is designated the neotype.

Among the cephalopods collected from the R/V *Anton Bruun* during United States participation in the International Indian Ocean Expedition was a series of octopus from East Africa having long dorsal arms and conspicuous buff-colored stripes and spots. These animals were at first thought to belong to *Octopus macropus* Risso, 1826, but were later considered to be conspecific with *Callistoctopus arakawai* Taki, 1964, from Japanese waters. Examination of material in the United States National Museum of Natural History disclosed specimens of *Octopus ornatus* Gould, 1852, that appeared to be the same. This latter material was received on loan along with other specimens from Oceania. Finally, two specimens were received from Hawaii along with color notes made when they were alive. Study of all of this material leads to the conclusion that *Octopus ornatus* is a widely distributed species of which *Callistoctopus arakawai* Taki is a synonym. The evidence is presented below.

The measurements and indices used are those of Voss (1963, p. 11) except for the designation HAI which is the length of the hectocotylized arm as a percentage of its fellow arm on the opposite side.

Octopus ornatus Gould, 1852

Figs. 1-3

Octopus ornatus Gould, 1852:476, fig. 590, 590a.—Tryon, 1879:112, pl. 30, figs. 29-30.—Robson, 1929:108.

Polypus ornatus.—Berry, 1909:418; 1914:294, pl. XLVI, figs. 1-2.

Callistoctopus arakawai Taki, 1964:292, pls. 2-3, text-figs. 34-41.

Octopus arakawai.—Dong, 1979:72, pl. 1, fig. 2.

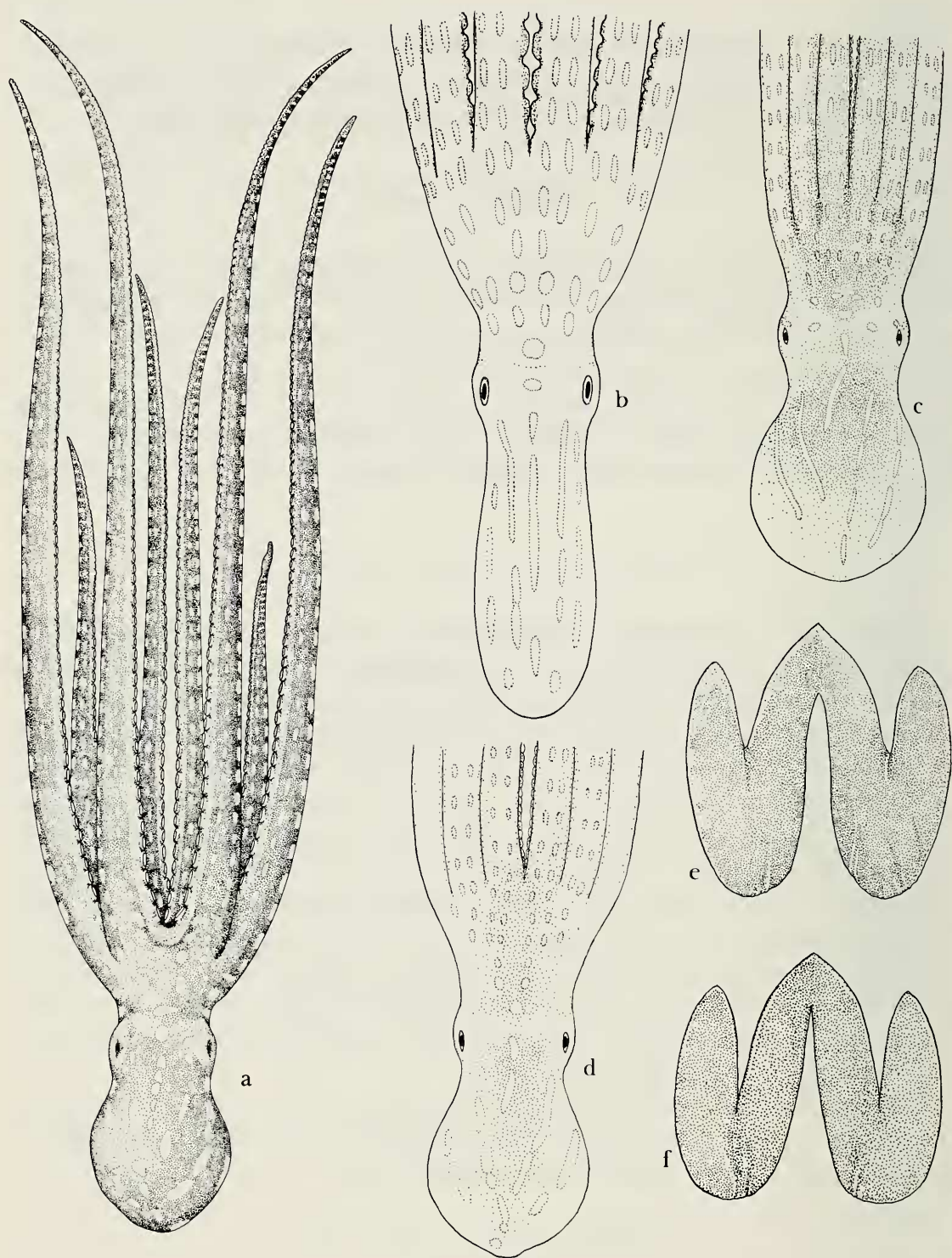


Fig. 1. *Octopus ornatus*: a, Dorsal view of neotype (88 mm ML); b, Color pattern and shape of 101 mm ML male from East Africa; c, Same of 47 mm ML male from East Africa; d, Same of 66 mm ML male from East Africa; e, Funnel organ of 101 mm ML male from East Africa; f, Funnel organ of 74 mm ML female from Hawaii.

Material examined.—Neotype, male, mantle length 88 mm, from Black Point, Oahu, Hawaii, collected by Stephen Kempf, 11 January 1976, USNM 730020.—1 female, mantle length 74 mm, Oahu, Hawaii, collected by C. F. E. Roper and R. E. Young, UMML 1756.—1 male, mantle length 83 mm, Market, Hawaii (*Albatross*) S.S.B. #382, USNM 214609.—1 male, mantle length 98 mm, Enyu Island, entrance to lagoon, Bikini Atoll, Marshall Islands, Schultz leg. 16 March 1946, USNM 574184.—4 females, mantle lengths 22–65 mm, USNM 730022.—1 male, mantle length 66 mm, USNM 730023, R/V *Anton Bruun*, cruise 9, sta. HA-1, Andromache Reef just south of entrance to Port Kalindi, Mombasa Harbor, Kenya in 0–1 meter, 15 November 1964.—2 males, mantle lengths 47–101 mm, same data as above, UMML 1756.—3 males, mantle lengths 44–104 mm, R/V *Anton Bruun*, cruise 9, sta. HA-2, Andromache Reef, just south of entrance to Port Kalindi, Mombasa Harbor, Kenya, in 0–1 meter, 16 November 1964, USNM 730021.

Description.—The description is based upon 15 specimens ranging in distribution from Hawaii to Bikini Atoll and East Africa. While the characters are consistent and show little variation over the species' range, some difficulties arise from the ability of the animals to elongate or contract the mantle. Round and tubular shaped mantles are found in the material and can have drastic effects upon indices. In the elongate stage the mantle length is greatly increased resulting in low indices in some characters and high ones in others. This problem should be borne in mind when using the indices.

The description is based primarily upon the large male from Oahu designated as the neotype.

The mantle is round, bulbular, smooth posteriorly or with a small terminal point, or it may be greatly elongate and tubular (MWI—males, 31–62.1–83; females, 27–60.7–70). It is muscular and thick-walled with a moderately wide aperture. The funnel is muscular, stout, and free for about half of its length. The funnel organ is W-shaped with the outer limbs a little shorter than the median ones.

The head is narrower than the mantle with (HWI—males, 32–45.9–57; females, 31–46.2–55) and in the specimens with round mantles there is a distinct neck region. In those with tubular mantles no neck region is found. The eyes are of moderate size and are somewhat protuberant.

The arms are long and stout (MAI—males, 15–18.2–23; females, 14–18.8–26; ALI—males, 82–84.8–87; females, 80–84.5–88), but taper to slender tips. The arm order in nearly all cases is I.II.III.IV with I the longest (two exceptions). The suckers are biserial and large (SIn—males, 7.9–11.4–15; females, 5–10–14) and there are no specially enlarged suckers in the males. The web is shallow (WDI—males, 9–11.4–14; females, 8–10.3–12).

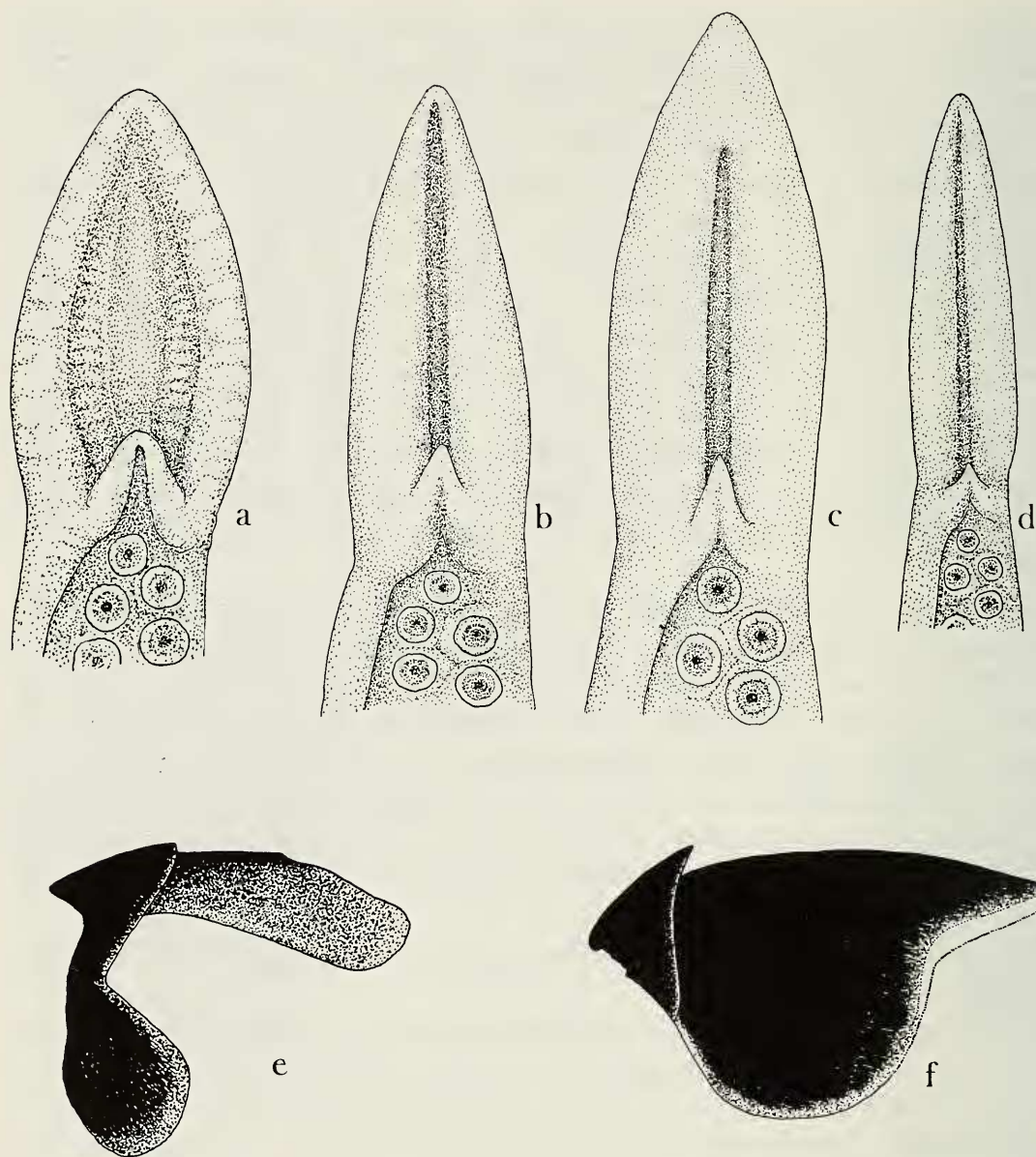


Fig. 2. *Octopus ornatus*: a, Hectocotylus of 47 mm ML male from East Africa; b, Hectocotylus of neotype (88 mm ML); c, Hectocotylus of 98 mm ML male from Bikini; d, Hectocotylus of 101 mm ML male from East Africa; e, Lower beak, f, Upper beak, of 101 mm ML male from East Africa.

The web formula is very variable but sector B is usually the deepest and sector E is usually the shallowest.

The third right arm is hectocotylyzed and is shorter than its fellow arm (HAI 59–68.7–82) (Fig. 2a–d). There is a distinct well-formed spermatophoral groove. The ligula is small (LLI—2.3–5.4–6.9) and is elongate with strongly inrolled lateral margins completely enclosing the deep, smooth longitudinal groove on the oral face. In small specimens the ligula is more open while in the specimen from Bikini the distal fifth of the ligula margins is

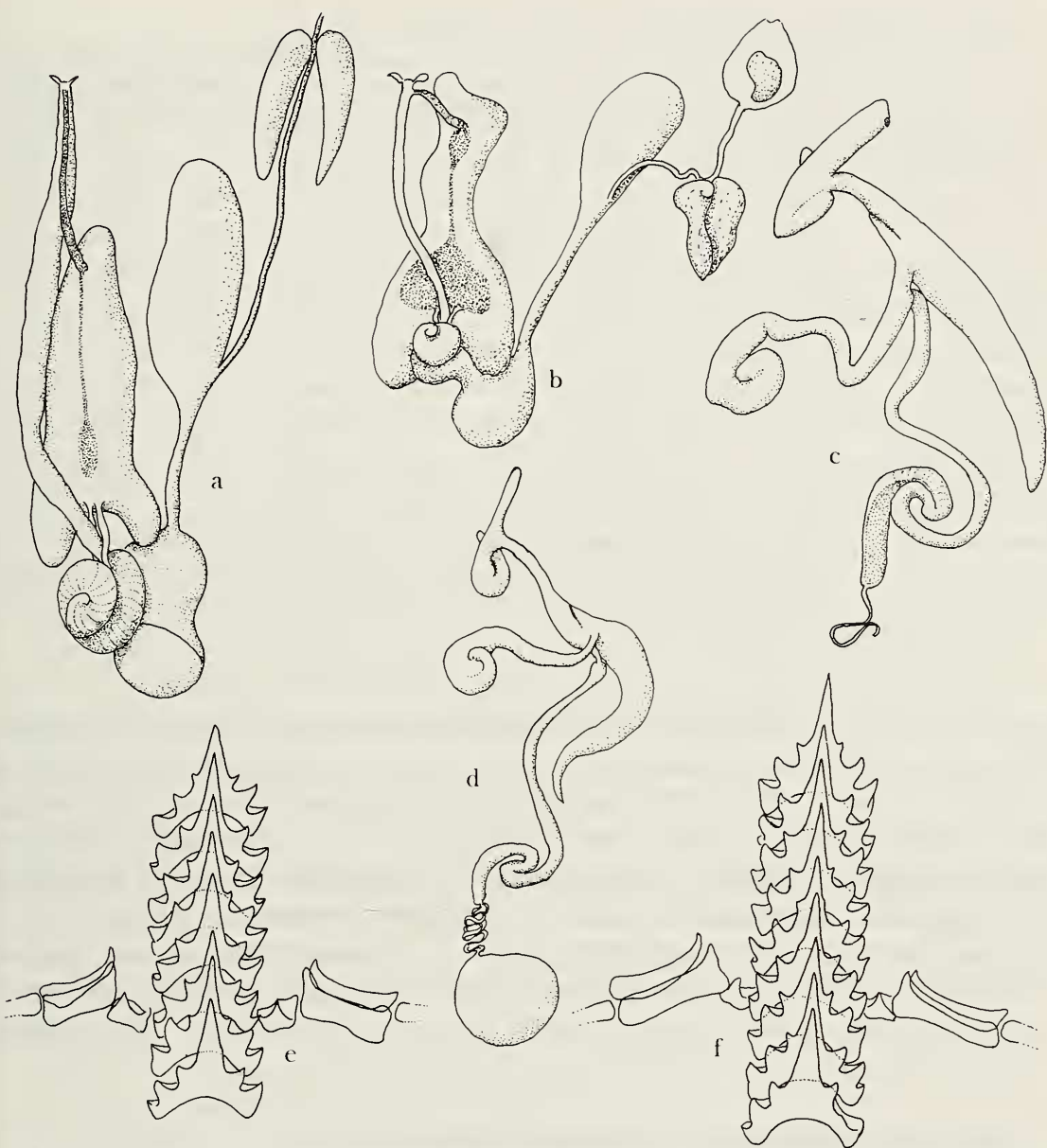


Fig. 3. *Octopus ornatus*: a, Digestive tract from 101 mm ML male from East Africa; b, Digestive tract from 74 mm ML female from Hawaii; c, Genitalia from 98 mm ML male from Bikini; d, Genitalia from 101 mm ML male from East Africa; e, Radula from 101 mm ML male from East Africa; f, Radula from 83 mm ML male from Hawaii.

fused together as shown in figure 2c. The calamus is small (CLI—13.6–23.7–39) and set flush with the margins of the ligula.

There are 12–14, more often 14, lamellae on the outer demibranch of the gills.

Several specimens were dissected to permit description of the digestive and reproductive tracts. The beaks are distinctive. The upper beak has a well-marked long notch in the cutting edge while the lower beak has a sharp ridge medially in the lamella which is divided in the posterior half. The

Table 1.—Indices and other data of 9 males of *Octopus ornatus*.

Index	Africa	Africa	Africa	Hawaii	Hawaii	Africa	Bikini	Africa	Africa
Mantle length	44	47	66	83	88	98*	98	101*	104*
Mantle width I	68	83	77	67	78	45	77	33	31
Head width I	50	53	53	42	57	35	56	32	35
Mantle arm I	15	16	17	15	16	22	18	22	23
Arm length I	87	86	86	87	86	82	85	82	82
Arm width I	25	22	23	17	24	18	—	17	13
Web depth I	11	11	11	12	9	14	—	12	—
Sucker Index normal	13	13	13	10	15	10	12	9	7.9
Hect. arm I	67	73	82	59	79	60	—	61	—
Ligula length I	2.8	2.3	6.9	4.6	6.6	4.9	6.0	6.2	—
Calamus length I	39	30	13.6	25	18.8	22.7	—	16.7	—
Arm formula	1.2.3.4	1.2.3.4	1.2.3.4	1.2.4.3	1.2.4.3	1.2.3.4	—	1.2.3.4	1.2.??
Web formula	BDCAE BACDE BCADE ACBDE BACDE ACBDE DBCEA BACDE ?								
Gills	12	13	13	13	14	14	14	13	14

* indicates elongate forms.

radula from both Hawaiian and East African specimens are very similar. Both have a symmetrical seriation of A⁶⁻⁸ with an average of A⁷, with about 2 cusps on each side of the rachidian. The digestive tract is very similar between the Hawaiian and East African specimens. Both show elongate posterior salivary glands, an enormous crop, large stomach and separated spiral caecum. The digestive gland of the Hawaiian female is elongate in the anterior part but wide posteriorly and has a 2-parted ink sac, the largest posterior. The East African specimen has an elongate gland (it is from a specimen with a tubular mantle) and a small posterior ink sac. Both glands

Table 2.—Indices and other data of 6 females of *Octopus ornatus*.

Index	Africa	Africa	Africa	Africa	Africa	Hawaii
Mantle length	22	33	47	64*	65	74
Mantle width I	68	70	66	27	63	70
Head width I	55	48	43	31	45	55
Mantle arm I	14	18	16	26	18	21
Arm length I	88	85	86	80	85	83
Arm width I	20	19	14	9	17	32
Web depth I	8	10	10	10	12	12
Sucker Index normal	9	14	11	5	9	12
Arm formula	1.2.3.4	1.2.3.4	1.2.3.4	1.2.3.4	2.1.3.4	2.1.3.4
Web formula	ABCDE	BACDE	BCDAE	A=CBDE	BCDA=E	BCD=AE
Gills	14	14	14	14	14	12

* indicates elongate forms.

are obviously modified for elongation. The posterior end of the glands is strongly bilobed.

The female genitalia are not illustrated as none of the specimens with viscera in good condition were adult. However, the ovary is not posterior but median and ventral in position, oval or squarish, with very long slender proximal and distal oviducts with small oviducal glands.

The male genitalia are very similar in all specimens. The one from Bikini has a long penis but over half of it is composed of a posterior diverticulum that is folded under itself and projects forward. The penial apparatus from an East African specimen conforms to this same general pattern but is longer and more slender, coming from an elongate-mantled specimen. The spermatophores of all the males were too incomplete to measure or illustrate.

The skin of the mantle, head and aboral surface of the arms and web is finely to roughly granulose, resembling that of *Octopus vulgaris* in some forms. There are a few large contracted papillae over each eye but not large enough to be classed as ocular cirri.

The color of the more recently preserved material at my disposal is purplish red dorsally on the mantle, head and arms. In long-preserved specimens the background color is reddish brown. Ventrally and on the oral surface of the arms and web the skin is a pale flesh color. The pattern of splotches, spots and stripes is very similar in all of the specimens and is well shown in the figures. Variations of mantle shape and color pattern are shown in the outline drawings. These spots and stripes are pale to bright buff. In some specimens, particularly those from East Africa, the spots and stripes have a raised ridge or crest or fleshy mound in their centers, the latter, especially on the arms, reminiscent of those found in *Octopus macropus*.

Type.—The original type-material has been lost. The neotype, a male, mantle length 88 mm is USNM 730020.

Type-locality.—Sandwich Islands, collected by the U.S. Exploring Expedition.

Discussion

The original specimens were from the Wilkes expedition “obtained at the Sandwich Islands at Oahu and Maui.” None of these specimens have been located in any of the museums where they might be expected to have been deposited, and all of these specimens in alcohol must be assumed to be lost (personal communication, Richard I. Johnson, Museum of Comparative Zoology, Harvard). The most important part of the original description is the following (Gould, 1852, p. 477): “The ground color is deep orange; beneath somewhat clouded with white; above variegated with five longitudinal buff stripes, the median one extending to between the eyes, the two lateral ones curving on each side, like median lines, and extending only to the neck;

between these lines, around the middle of the sac, are deep brown patches, and also between the bases of the arms; there are also brown mottlings along the back of the arms. These, with the pale, bubble-like patches around the base of the sac and along the arms, give a very gay and diversified coloring.”

This description of the color pattern almost exactly suffices for a description of the colors of the specimens from East Africa and of Taki's *Callistoctopus arakawai* (Taki, 1964: pl. 2).

An apparent discrepancy is the extremely narrow and elongate body of the African specimens. Some of these have narrower mantles than are known for adults of any other species of octopod. This is variable, however, and several specimens of normal mantle shape are in the series.

Examination of the digestive and reproductive tracts of both normal and elongated specimens shows that this species is especially adapted for shape change. This is seen in the elongated digestive gland (Taki, 1964, p. 295, noted that it nearly filled the mantle), the very long ink sac duct, and the long convoluted oviducts and anteriorly located ovary.

The two radulas figured, one from Bikini and the other from East Africa, are nearly exactly the same with symmetrically placed cusps on the rachidian and in a series of 7 to 8. Taki (1964, p. 294, figure 39) also shows a symmetrical series of 7 rather than 6 as he states in the text.

A variable feature requiring further study is the hectocotylus. Unfortunately, the hectocotylus described and figured by Berry (1914, pl. XLVI, fig. 2) is from an immature specimen and resembles that of immature specimens in the present material. The single male from Hawaii available to me has a long, slender but fully excavated ligula. The male from Bikini collected by Schultz has a narrow hectocotylus with a strongly inrolled ligula whose margins are fused together along the terminal fifth of its length. The question arises: does this represent an abnormality or a geographic variation? The African specimens are very similar to Taki's specimens from Japan and may represent the more “typical” condition.

Taki erected the genus *Callistoctopus* for his new species *arakawai* and *magnocellatus*. The characters by which he differentiated the genus from *Octopus* are “(1) large size, (2) robust construction, (3) characteristic color pattern, (4) reduction of ink-sac.” The size and robustness of construction are no greater than in many other species of *Octopus*, nor is the reduction in size of the ink sac of particular note. All of the specimens described here have a distinctive color pattern, in some ways resembling that of *Octopus macropus* (i.e. pale spots on body and arms). Certainly *magnocellatus* should not have been included as its color pattern is very dissimilar to that of *arakawai* and should be included among the regular ocellated species of *Octopus*. There is no valid basis for the retention of the genus *Callistoctopus* and it is placed in the synonymy of *Octopus*. *C. arakawai* is consid-

ered to be a synonym of *O. ornatus* Gould, 1852, a widely distributed Indo-West Pacific species.

Dong (1979: 72) has reported the occurrence of *arakawai* from off Xisha, Guandong Province, China, placing it correctly in the genus *Octopus*. A photograph of the specimen (pl. 1, fig. 2) shows that it is a long-bodied specimen resembling the elongate animals from East Africa.

A final question needs to be examined. Taki (1964:296–298, 301–304) stated that the living animal, although not personally seen by him, emitted “bluish phosphorescent light when stimulated; the light is emitted from the pink stripes and spots which are scattered all over the body surface except the ventral surface of body and arms; at that time the colour pattern looks thin-coloured than ordinary time.” Taki’s examination of the cellular structure of these “phosphorescent” areas revealed deeply-buried cells that he interpreted to be light producing cells but that seemed to me to be iridocytes or reflecting cells, especially as the latter are not mentioned in his histological comments. To verify this, I requested that Drs. Roper and Young, both with extensive knowledge of cephalopod luminescence, examine living specimens in Hawaii, if such could be found.

In a letter from Roper dated 20 November 1975 he wrote “The so-called luminescence surely is not true luminescence. Dick (R. E. Young) and I saw it and the girl (graduate student using the specimen for behavioral studies) saw it repeatedly under fairly well lit conditions. The animal pulls back its chromatophores and exposes the long patches of iridophores which exhibit iridescence and shimmer. It is vivid enough to be mistaken for luminescence—if you didn’t look too carefully.” The statement “pulls back its chromatophores” corresponds to Taki’s “the colour pattern looks thin-coloured than ordinary time.”

Roper and Young’s observations amply refute the existence of bioluminescence in this species and to date no octopod is known to possess luminescent organs (Thomas, 1977, p. 386, has shown that the supposed light organs in *Tremoctopus lucifer* Akimushkin, 1963, are not light organs). The specimen from which Roper and Young’s observations were made died shortly thereafter and was sent to me. It is a female and corresponds to the others in all particulars.

There is a complex of species in the Indo-West Pacific region characterized by the possession of long arms I. These animals have generally been assigned, without critical study, to *Octopus macropus*. In the light of the situation with regards to *Octopus ornatus*, other members of this complex need reexamination to determine their specific relationships.

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